SCADAPack E Conitel Slave Interface

Schneider Electric

Documentation

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I SCADAPack ER Conitel Slave Interface

Schneider Electric

Documentation

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All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed. Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

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2 Safety Information

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

	The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.
	This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result** in death or serious injury.

⚠CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result** in minor or moderate.

CAUTION

CAUTION used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** equipment damage..

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and the installation, and has received safety training to recognize and avoid the hazards involved.

BEFORE YOU BEGIN

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

⚠CAUTION

EQUIPMENT OPERATION HAZARD

- Verify that all installation and set up procedures have been completed.
- Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.

• Remove tools, meters, and debris from equipment.
Failure to follow these instructions can result in injury or equipment damage.

Follow all start-up tests recommended in the equipment documentation. Store all equipment documentation for future references.

Software testing must be done in both simulated and real environments.

Verify that the completed system is free from all short circuits and grounds, except those grounds installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to prevent accidental equipment damage.

Before energizing equipment:

- Remove tools, meters, and debris from equipment.
- Close the equipment enclosure door.
- Remove ground from incoming power lines.
- Perform all start-up tests recommended by the manufacturer.

OPERATION AND ADJUSTMENTS

The following precautions are from the NEMA Standards Publication ICS 7.1-1995 (English version prevails):

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer's instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer's instructions and the machinery used with the electrical equipment.
- Only those operational adjustments actually required by the operator should be accessible to the operator. Access to other controls should be restricted to prevent unauthorized changes in operating characteristics.

3 Preface

Purpose

The purpose of this document is to describe the SCADAPack ER RTU driver for the Conitel protocol, and using it for communicating with Conitel or Baker capable master station equipment.

References

Schneider Electric *SCADAPack ER-P620 Processor Hardware Manual*

Glossary

The terms in this glossary are described in the context of Conitel operation on SCADAPack E RTUs.

ACRONYM	DESCRIPTION
Byte	Unsigned 8-bit value
CD	Carrier Detect from Modem – connects to serial port CTS
CTS	Clear to send –indicates carrier detected on serial port
COS	Change of state
FC	Function Code in header of a Conitel message
LSB	Least Significant Bit
MSB	Most Significant Bit
PTM	Pre-Transmission Mark
PTT	Push-To-Talk output (for keying transmission)
R/L	Raise / Lower
RTC	Real time clock
RTS	Ready to send – keys an external Conitel modem
Word	Unsigned 16-bit value

4 Overview

Conitel is a half duplex (master/slave) bit-stream protocol developed by Leeds & Northrup. It is in wide use internationally, providing communication with RTU devices.

This document describes how the SCADAPack E firmware on the SCADAPack ER - P620 Processor Module communicates as a slave unit on a Conitel network.

The SCADAPack ER - P620 processor interfaces to Conitel communication circuits through V.28 (RS232 level) serial interfaces (see the SCADAPack ER - P620 hardware manual for more information). Up to 4 Conitel communication interfaces are supported simultaneously on the SCADAPack ER - P620 processor.

Operation with ITU-T V.23 or Bell-202 (FSK) interfaces for leased circuits requires the use of external modems.

Baker protocol is a variant of Conitel, compatible at the physical and framing level, and utilizing some of the same concepts as the Conitel protocol. The SCADAPack E firmware supports both Conitel and Baker protocol. Although the SCADAPack E configuration selects either Conitel or Baker operation, throughout this document the use of the both Conitel and Baker protocol is generally referred to simply as “Conitel”. See Section ***Baker Protocol*** 30 for information specific to Baker protocol.

This document outlines the following:

- Description of the Conitel and Baker protocols
- Physical interfaces to the Conitel network
- Mapping of Conitel data to SCADAPack E RTU points
- Processing and responding to received messages in the SCADAPack E firmware

The Conitel Slave protocol is supported on multiple ports on the SCADAPack ER - P620 processor module. Any combination of Ports 5~8 can be used. Where multiple Conitel ports are used simultaneously, they access a single RTU Conitel configuration and mapping database.

5 Conitel Protocol Configuration

- ***Supported Function Codes*** 10
- ***Physical Interface*** 14
- ***Conitel Port Configuration*** 15
- ***Conitel Slave Point Mapping*** 19
- ***Conitel Type Descriptions*** 28

5.1 Supported Function Codes

The Function Codes (FC) that are supported by the SCADAPack E Conitel driver are outlined in the following table:

Table 5.1: Conitel Function Codes

Fn Code (Hex)	FUNCTION	NOTES
0	Scan	Configurations for Responses to Scan are detailed in Section ***Adding a Scan Function*** 20
1	Execute	
2	Trip	Only 1 bit can be controlled in each Trip message. See Section ***Adding a Trip/Close Function*** 22
3	Setpoint (A)	See Section ***Adding an Analog Setpoint Function*** 27
4	Close	Only 1 bit can be controlled in each Close message. See Section ***Adding a Trip/Close Function*** 22
5	Setpoint (B)	See Section ***Adding an Analog Setpoint Function*** 27
6	--------	
7	--------	
8	--------	
9	Master Station Request	See ***Table 5.2: Function 9 Group Codes*** 11 for Group Codes
A	New SOE Events	Configurations for SOE points are detailed in Section ***Adding a Scan Function*** 20
B	Repeat SOE Events	
C	--------	
D	Unit Raise/Lower	When a Raise/Lower is currently being executed, a concurrently received Raise/Lower command replaces the in-progress command. Configuration is described in Section ***Adding a Raise/Lower Function*** 25
E	Freeze and Scan Accumulators	See Section ***Adding a Scan Function*** 20 for mapping Accumulators to scan groups
F	Freeze/Scan Accumulators and Reset	See Section ***Adding a Scan Function*** 20 for mapping Accumulators to scan groups

Table 5.2: Function 9 Group Codes

Group Code	Function	Supported	Notes
0	Unused		
1	Test RAM	✓	Returns good
2	Test PROM checksum	✓	Returns good
3	Test EPROM checksum	✓	Returns good as Conitel driver only boots if check passes
4	Test I/O Controller Data Bus	✓	Returns the state of the RTU's I/O Processing CPU
5	Download Data (Download Time)	✓	
6	Unused		
7	Unused		
8	Remote Status Request	✓	See ***Table 5.3 Remote Status Information*** 12 for supported status bits
9	Read Input Directly	✘	Not implemented
A	Read Comms parameters and time correction factor.	✓	
B	Repeat last message	✓	Valid if previous message has been sent
C	Unused		
D	Loop-back mode	✘	
E	'Warm' Restart RTU	✓	Sends an RTU hardware Restart
F	'Cold' Restart RTU	✓	Sends an RTU hardware Restart

Table 5.3: Remote Status Information

Fn 9 Group 8 Remote Status Frame Bits

Bit	Description	SCADAPack ER P620 Notes
1-4 (MSBs)	Error Code	See ***Table 5.4: Remote Status Frame Error Code*** 12 for error codes
5	Controls Isolated	Not supported
6	RTU Reset has occurred	Returns True (1) on the first status request after a reset then False (0) thereafter
7	Field Interrogator Supply is low.	Not implemented (0)
8	Power low	Internal Battery low or Input Supply low
9	Accumulator Overflow Change.	These 2 bits are represented by 'one-bit MCD' data type
10	Accumulator Overflow Status.	
11	SOE events overflow	Set if Conitel Event buffer has filled
12 (LSB)	SOE events present	Set when a Conitel event is generated. Cleared when all Conitel events are read

Table 5.4: Remote Status Frame Error Code

Fn 9 Group 8 Remote Status Frame 4-bit Error Code value

Error code (Hex)	Description	SCADAPack ER - P620 Notes
0	Normal Operation	
1	Power fail	From power low bits (see table above)
2	Spare	
3	Control Error	Set if control cannot be executed. E.g. if sent to a point under ISaGRAF control, or point not configured correctly
4	Comms Error	Not implemented
5	Configuration/Scan Error	Set if there is an error in the Conitel table configuration.
6	Timer Overrun	Not implemented
7	Address Error	Not implemented
8	Bus Error	Not implemented

9	Software Error	Set if a software watchdog was previously detected (and not cleared)
A	Spare	
B	RAM Error	Not implemented
C	I/O Controller Hardware error	Set if an error is returned from RTU's I/O processing CPU
D	Configuration PROM Checksum test failure	Not implemented
E	Program PROM Checksum test failure	Not implemented
F	Reset Operation (Fn 9, Code E or F) in progress.	Not implemented

5.2 Physical Interface

The physical interface provided by the SCADAPack ER - P620 processor for Conitel ports is 4 x RJ-12 ports, using V.28 (RS232 levels). These can be used on a direct V.28 Conitel interface, or connected to a V.23 or Bell 202 modem. Conitel is usually transmitted over 4-wires using Bell 202 or ITU-T V.23 at 1200 baud. The RTS line from the RJ-12 port acts as RTS (also known as PTT) for the modem. The CTS line on the RJ-12 port is used as a CD line from the modem.

See the *SCADAPack ER Hardware User Manual* for cable wiring information for RJ-12 ports.

Two configuration parameters are provided for each Conitel port: *PTM Time* and *Squelch Time.* For received Conitel data to be validated, the carrier needs to be received for a period longer than the configured *Squelch Time,* and the data needs to pass the Conitel framing checks.

When transmitting messages out a Conitel port, the driver will first key the RTS line and then assert the *PTM* for the configured length of time. See Section ***Communication Timing & Control/Execute Timeout (Communication Timing)*** 17 for more information.

5.3 Conitel Port Configuration

To configure a SCADAPack ER - P620 processor for Conitel operation, select the SCADAPack ER then P620 model processor module when you first start SCADAPack E Configurator.

You can also select this later by using "*View->Change RTU Model…*" and select SCADAPack ER, then SCADAPack ER - P620.

On the "Ports 5-8" page, configure at least one port for **Conitel Slave**. Set the required Conitel configurations, as in the example below. Download the configurations to the RTU when you have completed the RTU configuration.

Connect the SCADAPack ER - P620 processor to a suitable V.28 interface, V.23 or Bell 202 modem using the hardware lines as described in Section ***Physical Interface*** 14.

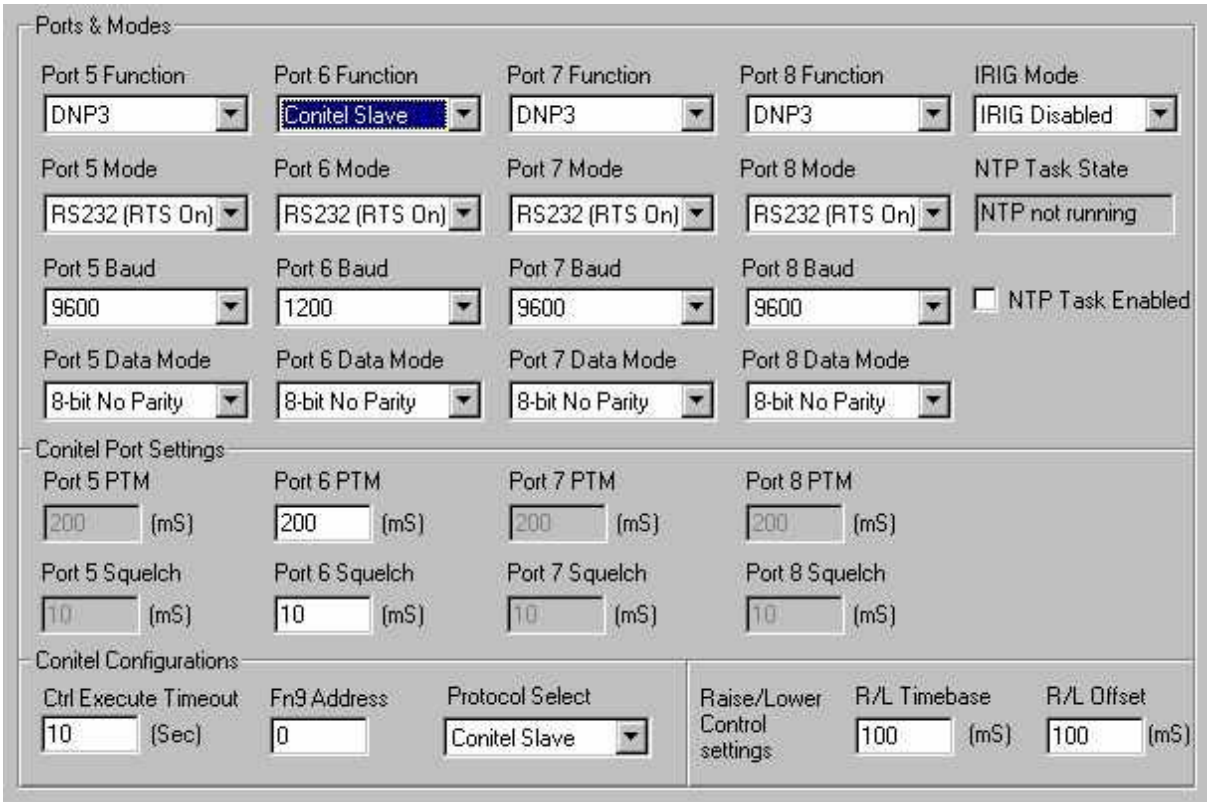

Figure 5.1: Conitel Port Configuration

- ***PTM and Squelch & Control/Execute Timeout*** 16
- ***Communication Timing & Protocol Select*** 17
- ***Function 9 Address & Raise/Lower Control Settings*** 18

5.3.1 PTM and Squelch & Control/Execute Timeout

PTM and Squelch

The PTM and Squelch values required will depend on the physical network that you are transmitting across. The PTM is transmitted at the start of a message and its value is dependant on the transmission delays across the network and the delays inherent in stabilizing transmitting and receiving modems. The Squelch time is used to determine if a valid message is being received. When Carrier Detect is received by the RTU, the Conitel driver will verify that the inbound PTM is longer than the configured Squelch. It does this by starting the squelch timer following reception of the CTS (CD) signal, then starts looking for a Conitel frame Start Bit following the squelch time period. The Squelch time at the receiver is therefore dependent on not only the transmission times on the network, but also the PTM at the other (transmitting) end. See ***Figure 5.2 Conitel Communication Timing*** 17.

Control/Execute Timeout

This timer is started when a valid Trip/Close or Setpoint A/B function code is received. If the corresponding Execute command is not received within this timeout, then the control is discarded.

5.3.2 Communication Timing & Protocol Select

Communication Timing

The following diagrams show the relationship between the various timing parameters

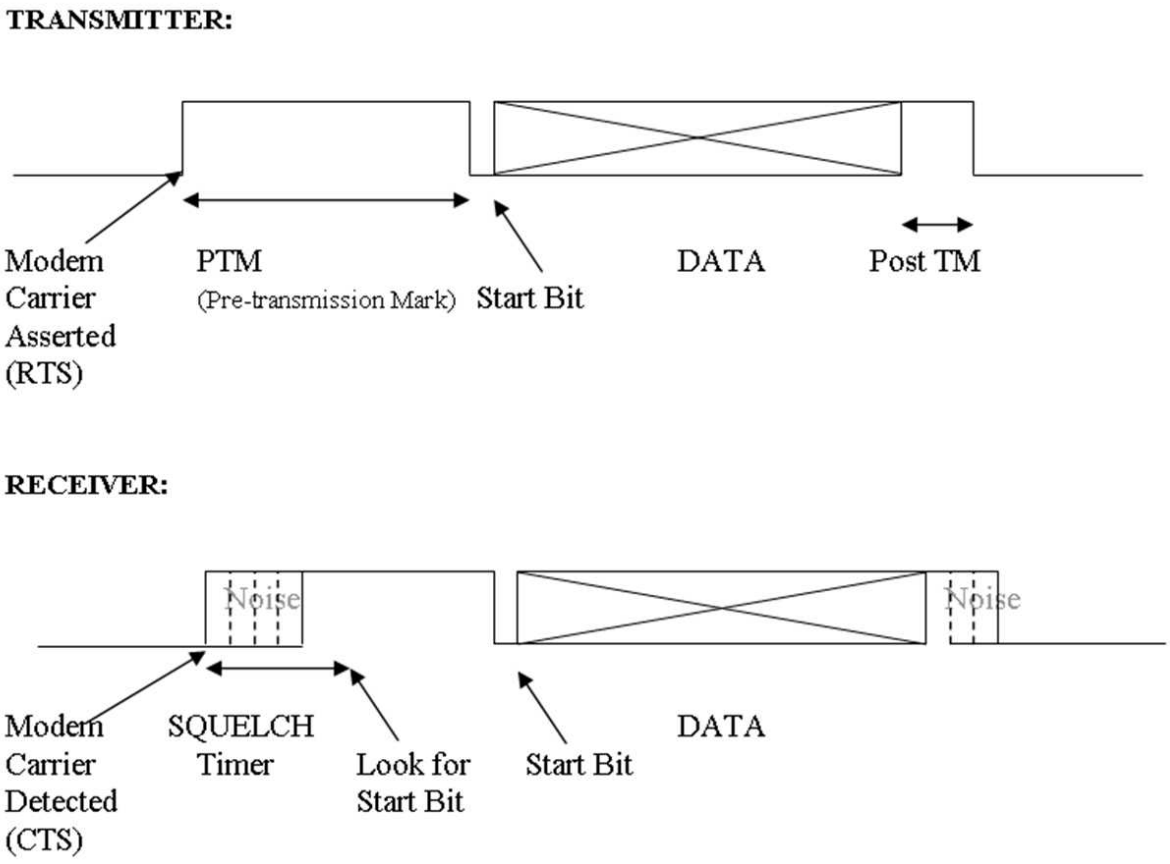

Figure 5.2: Conitel Communication Timing

For information on Post Transmission Mark (Post TM) parameters, see Section ***Appendix - System Points*** 33 **(Post Transmission Mark)** 33.

Protocol Select

Select whether the system is running Conitel or Baker protocol. Also see Section ***Baker Protocol*** 30.

5.3.3 Function 9 Address & Raise/Lower Control Settings

Function 9 Address

This address needs to be configured if you require the SCADAPack E firmware Conitel driver to respond to Conitel Function 9 requests. If configured, then this RTU will respond to Function 9 requests directed at this address.

As the SCADAPack E firmware Conitel driver can respond to multiple Conitel Station and Group addresses (see below), this field is available to allow operation of Function 9 in conjunction with multi-dropping of RTU's.

Raise/Lower Control Settings

These settings relate to Raise/Lower (R/L) controls. A Raise/Lower control for a single point in Conitel consists of 4-bits of information. One bit determines whether it is a raise or lower control, and the other three bits determine the number of periods (N) to pulse the point for. The total period of time that the point is pulsed, is calculated by the following formula:

Pulse Period = *R/L Offset*(ms) + (*R/L Timebase* x N)(ms).

For example, if *R/L Offset* = 250ms and *R/L Timebase* = 150ms, then for a Raise control received with N=3, the Raise output will be pulsed for 250 + 150*3 = 700ms.

Generally, R/L controls are used so that a *Raise* command pulses one physical output point, and a *Lower* command pulses a different physical output point. However, R/L controls may be passed through a data concentrator to remote devices. See Section ***Adding a Raise/Lower Function*** 25 for further information on point mapping for Raise / Lower controls.

5.4 Conitel Slave Point Mapping

To map RTU points through to the Conitel Slave interface, a “Conitel Slave” page is provided in the RTU configuration software. To access this page, check that the hardware type is set as **SCADAPack ER - P620** in the “Change RTU Model” wizard and that **Conitel Slave** is also selected in the “RTU Features” dialog.

The Conitel Slave page consists of 2 graphical tables:

- The first table is used for adding station/groups that the RTU is to respond to for various function codes. Once a station/group/function entry has been added to this table, then points can be mapped to it using the Point Mapping table.
- This second table maps RTU points to positions in the selected Conitel response frame.

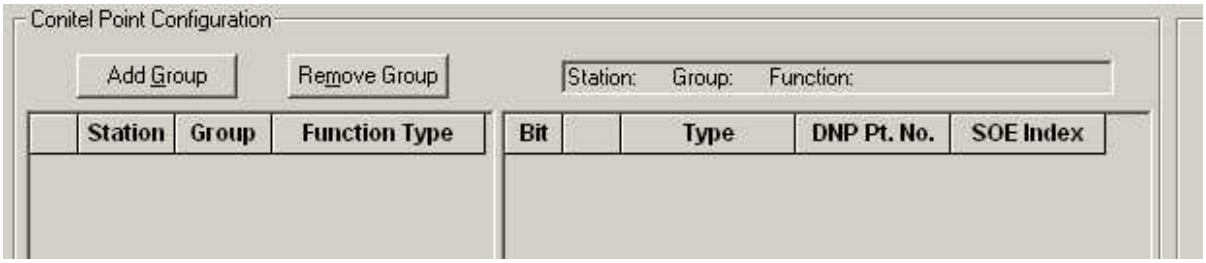

Figure 5.3: Conitel Point Configuration

The following functions are supported for Conitel station/group entries:

- Scan Fn
- Trip/Close Fn
- Raise/Lower Fn
- Setpoint Fn

The function menu includes “Reset Fn (Baker)” but this is specifically for Baker protocol only (see Section **Function Codes and Data Types [Reset]** 32) and is not supported by Conitel.

- ***Adding a Scan Function*** 20
- ***Adding a Trip/Close Function*** 22
- ***Adding a Raise/Lower Function*** 25
- ***Adding an Analog Setpoint Function*** 27

5.4.1 Adding a Scan Function

Press the "**Add Group**" button and select *Scan Fn* as the Response Type. Give the response group appropriate Conitel Station and Group numbers. A new row will be added to the table on the left. Select this row and then the available 31 frames will be shown in the Point Mapping table on the right.

RTU points can now be added to the Scan response Point Mapping table by first selecting a Type from the available drop-down list and then attaching an appropriate RTU database point for this type.

For a list and description of the various Conitel Point types see ***Table 5.7 Conitel Point Type*** 28.

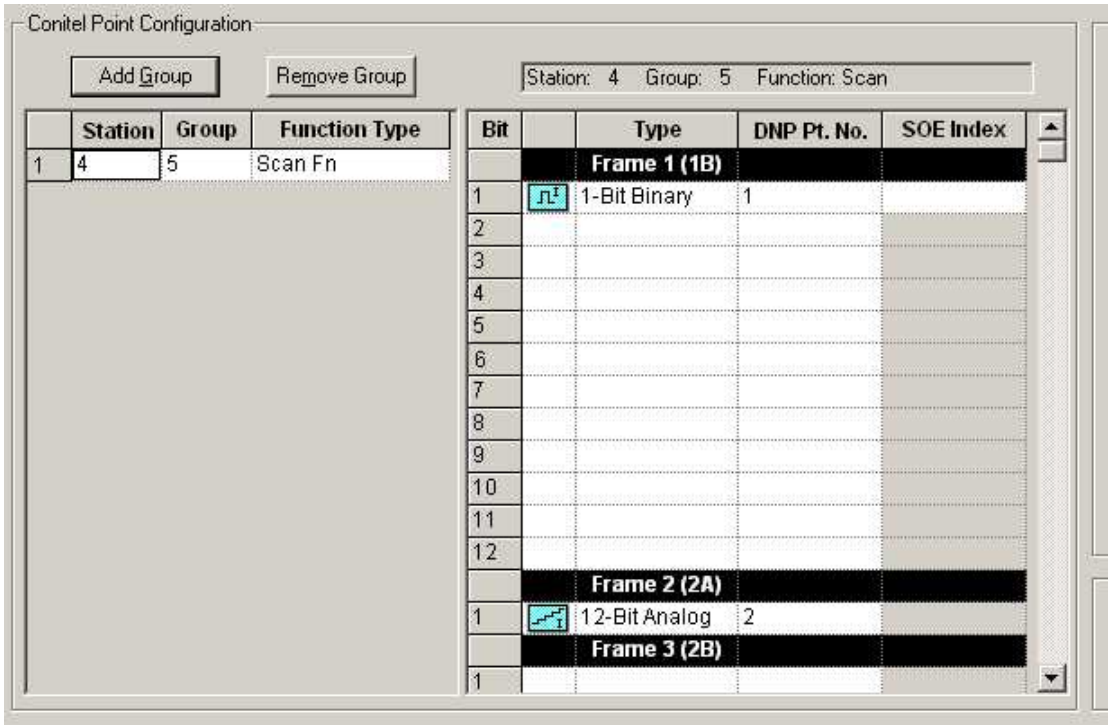

Figure 5.4: Scan Function Configuration

The following restrictions apply when selecting the Conitel Type:

- A Conitel scan response can maximally return 31 frames. Each frame contains 12 bits
- Frames containing user specified data are labeled 1B, 2A, 2B, …. 16A, 16B
- SOE ID's can only be set when the Conitel Type is binary (i.e. 1-bit binary or 2-bit MCD). Each RTU has a limit of 120 unique SOE ID's
- 2-Bit MCD types consume 2-bits in the frame, and can only be located at odd bit numbers in the frame
- Analog points, Status frame, and 12-bit Accumulators consume a whole frame (12-bits). The remainder of the bits in the frame will not be shown if these types are selected. They can only be selected on the first bit in a frame
- The status register does not require a database point number
- RTU database Analog Point scaling should be used to scale physical analog inputs into the 12-bit

range -2048 to 2047.

- 24-bit Accumulators consume 2 frames. This type also can only be located as the first bit in a frame, and it cannot be located in the last frame (frame 16B).
- RTU Database points are selected by their DNP3 address (even if they are not being used for DNP3 communications)

If the selected point currently does not exist in the RTU point database, then the user will be prompted to add the point, if desired.

5.4.2 Adding a Trip/Close Function

Press the "**Add Group**" button and select *Trip/Close Fn* as the Response Type. Give the response group appropriate Conitel Station and Group numbers. Select this row in the response group table, and then the available frame will be shown in the Point Mapping table on the right hand side. Trip/Close controls can only utilize 12 control points (i.e. a single frame).

To pulse physical output points using the Trip/Close function code, two points are required in the SCADAPack E RTU database. A main point and a partner point needs to be configured. In this case, the pulse duration for the outputs is determined by the output point's configured "Output Pulse Time" attribute, which needs to be non-zero to operate correctly.

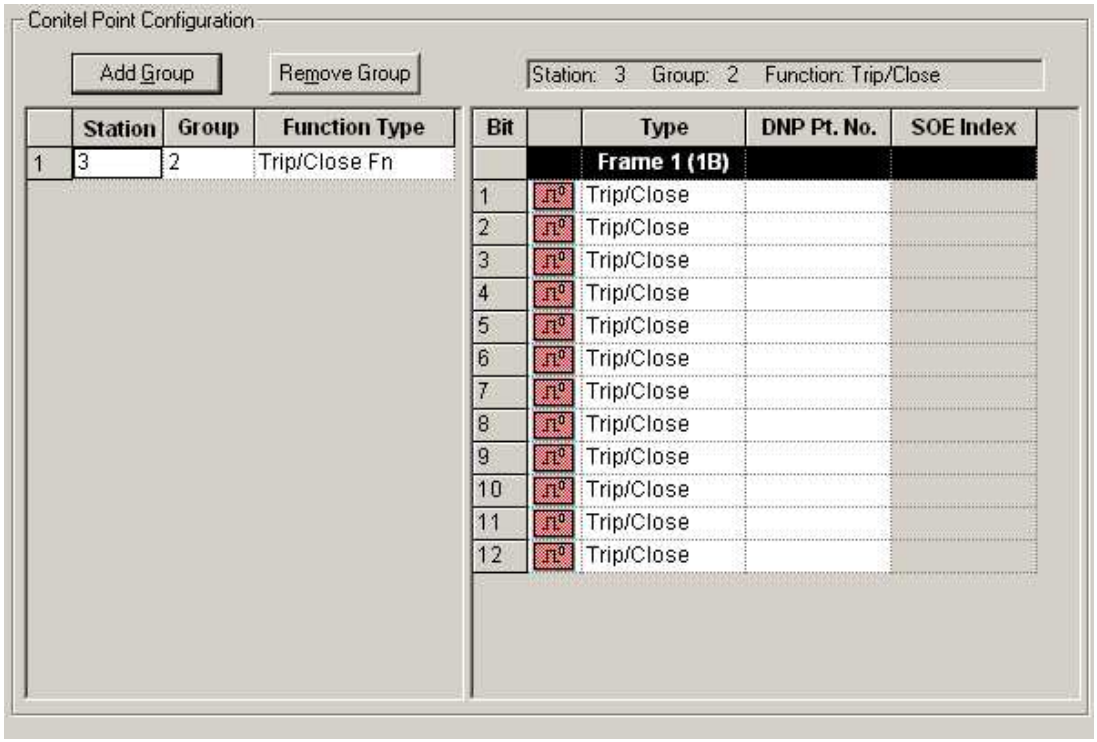

Figure 5.5: Trip/Close Function Configuration

Conitel Trip/Close commands may operate as Pulse, Latch or Unlatch commands to the SCADAPack E RTU or RTUs remote from the RTU using Conitel, depending upon the configuration of the mapped SCADAPack E RTU points. See ***Table 5.5*** 23.

Where SCADAPack E RTU is used as a Conitel Slave and where points on its local output modules are used for Trip / Close commands, the 2 Trip points need to be configured as ***partner points*** in the RTU. Only one of the two points needs to be mapped to the Trip/Close control in the RTU configuration. For more information on partner points see the ***SCADAPack E Configuration Technical Reference.***

Where an SCADAPack E RTU is used as a Conitel Slave and a data concentrator to other devices (e.g. DNP3 RTUs), a partner point MAY be defined but is NOT required to be defined for Trip / Close controls. This allows controls to be sent to remote RTU devices using either "single index" or "dual index" addressing.

The following table describes the result of receiving Conitel Trip / Close controls.

Table 5.5: SCADAPack E RTU Trip / Close Command Results

Operation as / Output point location	Conitel Control Received	Output point's Pulse Time field value:	Output point's Partner Point field value:	Result
End node RTU / Physical output on RTU module	TRIP	Non-zero	Valid index of partner point (not 65535) MANDATORY	Timed PULSE operation on the physical output point (lowest point number of the partner point pair)
	CLOSE	Non-zero	Valid index of partner point (not 65535) MANDATORY	Timed PULSE operation on the physical output point (highest point number of the partner point pair)
End node RTU / Physical output on RTU module	TRIP	0	IGNORED	UNLATCH operation on the local output point mapped in the Conitel Slave table
	CLOSE	0	IGNORED	LATCH operation on the local output point mapped in the Conitel Slave table
Data concentrator / Output on remote RTU	TRIP	Non-zero	65535 (disabled)	Timed DNP3 TRIP command sent to (single index) remote RTU point
	CLOSE	Non-zero	65535 (disabled)	Timed DNP3 CLOSE command sent to (single index) remote RTU point
Data concentrator / Output on remote RTU	TRIP	Non-zero	Valid index of partner point (not 65535)	Timed TRIP command sent to (dual index) remote RTU output point equivalent to lowest point number of the partner point pair
	CLOSE	Non-zero	Valid index of partner point (not 65535)	Timed CLOSE command sent to (dual index) remote RTU output equivalent to the highest point number of the partner point pair
Data concentrator / Output on remote RTU	TRIP	0	IGNORED	UNLATCH command sent to remote RTU point
	CLOSE	0	IGNORED	LATCH command sent to

Operation as / Output point location	Conitel Control Received	Output point's Pulse Time field value:	Output point's Partner Point field value:	Result
				remote RTU point

5.4.3 Adding a Raise/Lower Function

Press the "**Add Group**" button and select *Raise/Lower Fn* as the Response Type. Give the response group appropriate Conitel Station and Group numbers. Select this row in the response group table, then the available frame will be shown in the Point Mapping table on the right hand side. Raise/Lower controls from the master can only utilize 3 control points, as each control in the frame uses 4-bits.

For the pulse to work correctly in Raise/Lower controls, the appropriate timing parameters need also be setup (see Section ***Function 9 Address & Raise/Lower Control Settings*** 18 **[Raise/Lower Control Settings]** 18).

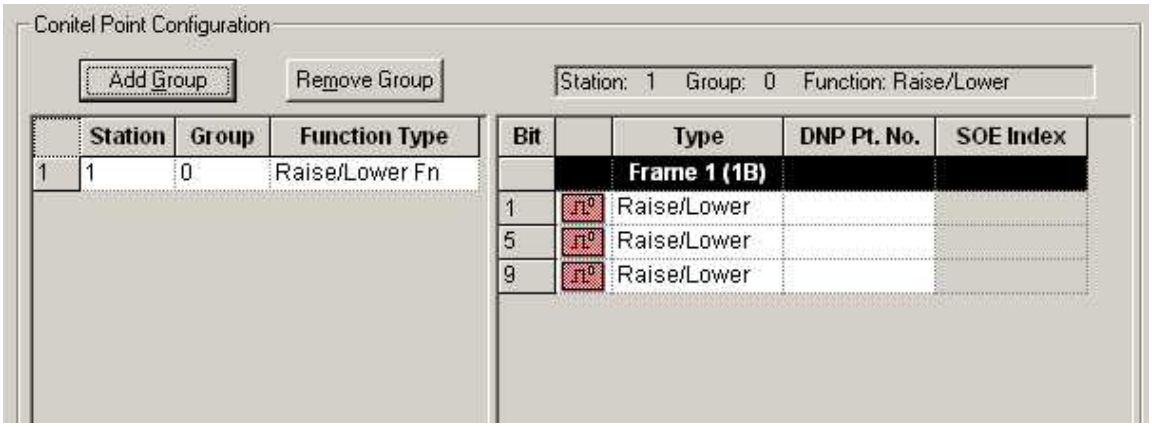

Figure 5.6: Raise/Lower Function Configuration

Where an RTU is used as a Conitel Slave and where points on its physical output modules are used for R/L commands, the 2 R/L points needs to be configured as ***partner points*** in the RTU. Only one of the two points needs to be mapped to the R/L control in the RTU configuration. For more information on partner points see the *SCADAPack E Configuration Technical Reference*.

Where an SCADAPack E RTU is used as both a Conitel Slave and a data concentrator to other devices (e.g. DNP3 RTUs), a partner point MAY be defined but is NOT required to be defined for R/L controls. This allows controls to be sent to remote RTU devices using either "single index" or "dual index" addressing.

The following table describes the result of receiving Conitel Raise / Lower controls.

Table 5.6: SCADAPack E RTU Raise / Lower Command Results

Operation as / Output point location	Conitel Control Received	Output point's *Partner Point* field value:	Result
End node RTU / Physical output Physical RTU module	RAISE	Valid index of partner point (not 65535) MANDATORY	Timed PULSE operation on the physical output point (lowest point number of the partner point pair)
	LOWER	Valid index of	Timed PULSE operation on the

		partner point (not 65535) MANDATORY	physical output point (highest point number of the partner point pair)
Data concentrator / Output on remote RTU	RAISE	65535 (disabled)	DNP3 CLOSE command with calculated pulse time sent to (single index) output point on remote RTU
	LOWER	65535 (disabled)	DNP3 TRIP command with calculated pulse time sent to (single index) output point on remote RTU
Data concentrator / Output on remote RTU	RAISE	Valid index of partner point (not 65535)	DNP3 CLOSE command with calculated pulse time sent to (dual index) remote RTU output point equivalent to the highest point number of the partner point pair
	LOWER	Valid index of partner point (not 65535)	DNP3 TRIP command with calculated pulse time sent to (dual index) remote RTU output equivalent to the (lowest point number of the partner point pair)

5.4.4 Adding an Analog Setpoint Function

Press the "**Add Group**" button and select *Setpoint Fn* as the Response Type. Give the response group appropriate Station and Group numbers. Select this row in the response group table, and then the available frames will be shown in the Point Mapping table on the right hand side. There are 2 separate Analog setpoints available for each Station/Group combination. These are referred to as Setpoint A and Setpoint B controls and they utilize different function codes in the Conitel protocol. Each setpoint may be mapped to an SCADAPack E RTU database analog point.

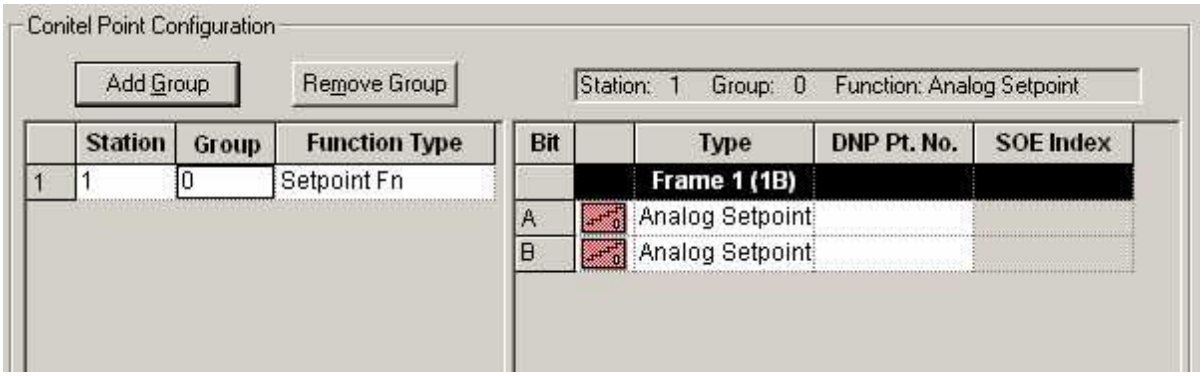

Figure 5.7: Analog Setpoint Function Configuration

5.5 Conitel Type Descriptions

The table below outlines the various Conitel data Types available when mapping SCADAPack E RTU points to Conitel frames.

Table 5.7: Conitel Point Types

Conitel Type	Description	Number of bits	Notes
NIL			
1-Bit Binary	Single binary value	1	
2-Bit MCDA Binary	OFF to ON transition detection. Status of input is inverted	2	Must be allocated to an **odd** bit number in the configuration
2-Bit MCDB Binary	ON to OFF transition detection	2	
2=Bit MCDC Binary	More than 1 transition detected	2	
12-Bit ANALOG	Analog point (range –2048~2047)	12	
12-Bit Accumulator	Accumulator (range 0~4095)	12	
24-Bit Accumulator	Accumulator (range 0~16777216)	24	
TRIP/CLOSE Output	Digital Output bit – single binary	1	
ANALOG Output	Analog Output point (range 0~4095)	12	
RAISE/LOWER Output	Raise/Lower pulsed output	4	
STATUS Frame	RTU status frame (known as Conitel Remote Status) - see ***Table 5.3 Remote Status Information*** 12	12	Status frame can only be mapped once in an SCADAPack E RTU

MCD = Momentary Change Detect. MCDA = MCD type A; MCDB = MCD type B; MCDC = MCD type C.

- ***Notes/Restrictions*** 29

5.5.1 Notes/Restrictions

The RTU's Conitel driver performs configuration validation on start-up. RTU Error Code 3005 is generated if a Conitel configuration is found to be invalid.

The following items describe the operation of the SCADAPack E RTU Conitel driver:

- Station address 0 will be processed by the RTU as this is a broadcast address. No response will be generated.
- If the Conitel Driver encounters an error while in the process of decoding or responding to a valid request from the master station, then it will cancel the current transmission (i.e. drop PTT).
- The SOE buffer in the Conitel driver will store up to 500 events. There are 2 of these buffers, one for the current (unreported) events, and one for the previously reported events (used with Function Code B).
- A 'frozen accumulator' buffer stores the last frozen accumulator values.
- When FC 9 is used then the Group address becomes a sub-code. This means that the only way to identify a device address for a FC 9 request is by using the Station address bits. However, multiple physical devices may share the same Station address so they would respond to a FC 9 request at a given Station address. (In many cases devices are segregated by Station address AND Group address. In the case of FC 9 the group address is used for a different purpose, potentially causing a problem). A separate FC 9 address configuration is provided by the SCADAPack E RTU to overcome this. Where function code 9 is used in a system, the configuration of this field needs to be unique between RTUs multi-dropped on the same Conitel communications link.
- Accumulators that internally can have values larger than their type can represent (i.e. either larger than 12 or 24 bits) will wrap when the limit for that type is reached. I.e. the least significant 12 or 24 bits will be presented.
- If a Raise or Lower operation for a given point is already executing and concurrently a new Raise or Lower command is received for the same point, the SCADAPack E RTU will replace the currently executing operation with the newly received operation, as per the Conitel specification.
- Raise/Lower command: A Raise command translates to a CLOSE control when mapped to other protocols in an SCADAPack E RTU (DNP3, IEC60870-5 suite, etc). A Lower command translates to a TRIP control.

6 Baker Protocol

The Baker Slave Protocol is very similar to the Conitel Slave Protocol. The RTU's Conitel Driver can be configured to interpret frames in Baker compatible format. This section outlines the differences in the two protocols, and the aspects of the configuration that change when Baker Protocol is selected.

- ***Bit Ordering, Address Header, & Notes and Restrictions*** 31
- ***Function Codes and Data Types*** 32

6.1 Bit Ordering, Address Header, & Notes and Restrictions

Bit Ordering

In Baker Protocol, the bits in each frame are numbered 12(MSB) – 1(LSB), with bit 12 is the first bit transmitted. This is the opposite of the Conitel Protocol which numbers 1(MSB) – 12(LSB) and transmits bit 1 first. The Conitel Point Mapping table has bit numbers going from 1(MSB) to 12(LSB).

The user needs to be aware of this and convert numbering in the Point Mapping table appropriately when using Baker protocol.

Address Header

The Address Header frame has 3-bits for the function code, 6-bits for the Station Address, and 3-bits for the Set Address. The most significant bit of the station address is set aside for the execute function code (see Section ***Select Execute*** 32). The functions codes specified for the first 3-bits match the same function codes as described by the Conitel Protocol above. The 5-bit Station Address specifies one of up to 32 RTU's on a communication channel.

The Set Address for the Baker Protocol selects which particular set of inputs or outputs are to be accessed. Typically, Baker protocol requires mapping as follows:

- 000 – AI Scan (or Control Activate)
- 001 – 1st set of 12 control points available for Trip/Close
- 010 – 2nd set…
- 011 – 3rd set…
- 100 – 4th set…
- 101 – 5th set…
- 110 – MCD and SDI Scan
- 111 – SDI Scan

Notes and Restrictions

When selected for operation with the Baker protocol, the following Conitel configurations are not used (as they are not supported by Baker protocol):

- Fn9 Address
- R/L Timebase
- R/L Offset

The RTU's Conitel / Baker driver performs configuration validation on start-up. RTU Error Code 3006 is generated if a data type is configured that is not supported by Baker protocol.

6.2 Function Codes and Data Types

The Baker protocol supports the following Function Codes:

- 0 – Scan
- 1 – Execute
- 2 – Trip
- 4 – Close
- 8 – Reset

The user should not configured other Function Codes (i.e. Raise/Lower and Setpoint functions are not supported in Baker protocol mode)

Scan

The data types supported for the Scan function with Baker protocol are:

- BIN1 – Single bit binaries
- MCC – Multiple change detect
- ANALOG – Signed 12-bit analog
- STATUS – 12-bit Status register supported

The user should not configure other data types when using Baker protocol.

Select Execute

The most significant bit of the BAKER address bits is set aside for the EXECUTE command. This is issued following a TRIP/CLOSE select. This effectively means the function code is a 4-bit number and an execute command will set the first bit (along with the select function code).

For example, when a Select/Execute control is performed on the RTU, the sequence of function codes sent to the RTU would be:

- For a TRIP, fn code 0x2, followed by an EXECUTE-TRIP fn code 0x3.
- For a CLOSE, fn code 0x4, followed by an EXECUTE-CLOSE fn code 0x5.

The SCADAPack E firmware manages the Baker protocol differences for Execute. The user does not required to make any additional considerations compared with its use with Conitel protocol.

Reset

The RESET function code will send a pulse command to the mapped RTU database point. For this control to work successfully, the point configuration for the output point needs to include a pulse time. The Reset command will operate in the RTU without receiving an Execute command.

7 Appendix - System Points

Configuration System Points

The following table defines the SCADAPack E Conitel driver configuration System Points. These points are 16-bit analogs.

Table 7.1: SCADAPack E Conitel Slave RTU System Points

DNP Point Number	Default Value	Name	Description
57300	200	Port 5 PTM	Pre-transmission mark (ms)
57301	200	Port 6 PTM	Pre-transmission mark (ms)
57302	200	Port 7 PTM	Pre-transmission mark (ms)
57303	200	Port 8 PTM	Pre-transmission mark (ms)
57304	10	Port 5 Squelch	Squelch time (ms)
57305	10	Port 6 Squelch	Squelch time (ms)
57306	10	Port 7 Squelch	Squelch time (ms)
57307	10	Port 8 Squelch	Squelch time (ms)
57308	10	Ctrl Execute Timeout	Timeout between a control and execute (S)
57309	0	Fn 9 Address	Address to respond to Fn 9 requests
57310	100	R/L Timebase	Raise Lower Timebase (see Section ***Function 9 Address & Raise/Lower Control Settings [Raise/ Lower Control Settings]*** 18)
57311	100	R/L Offset	Raise Lower Offset (see Section ***Function 9 Address & Raise/Lower Control Settings [Raise/ Lower Control Settings]*** 18)
57312	0	Protocol	Select between slave protocols: 0 – Conitel Slave 1 – Baker Slave
57313	1	Port 5 Post TM	Post-transmission mark (ms)
57314	1	Port 6 Post TM	Post-transmission mark (ms)
57315	1	Port 7 Post TM	Post-transmission mark (ms)
57316	1	Port 8 Post TM	Post-transmission mark (ms)

Post Transmission Mark

The Post Transmission Mark parameters shown in ***Table 7.1 SCADAPack E Conitel Driver System Points*** 33 are not brought out to the RTU Configuration software directly. In many circumstances the default value for a port's Post TM is sufficient (1 ms). However, if data corruption is occurring at the end of messages, this time can be extended by setting the RTU System point for the appropriate port.

Also see communication-timing diagrams in Section ***Communication Timing & Protocol Select (Communication Timing)*** 17.

8 Appendix - Conitel Protocol Summary

- *Conitel Frames* 36
- *Address Header* 37

8.1 Conitel Frames

The Conitel protocol is a bit-wise protocol where 32-bits comprise a Block. In a single Conitel message there is a maximum of 16 Blocks (therefore maximum Conitel message size is 512 bits).

The first Conitel 32-bit Block has the following format. The PTM and Start-bit are not included in subsequent Blocks:

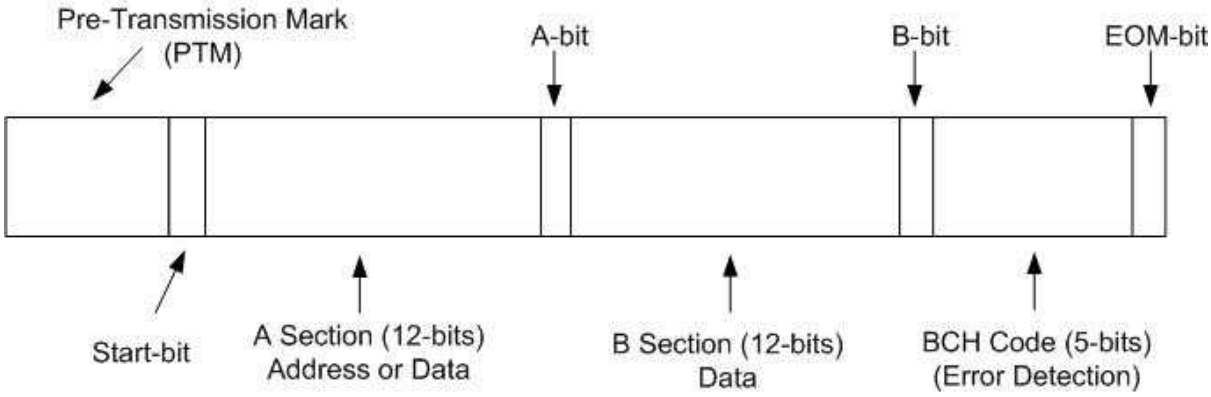

Figure 8.1: Conitel Header Block

The **PTM** and **Start-bit** pre-pend the first Block in a message. The Start-bit is 0.

The first **A Section** of a message will be an address header frame (see Section *Address Header* 37), then subsequent Sections will be data (Sections are also referred to as **Frames**). The **A-bit** will be 0 if the A-section contains the address header or 1 otherwise for data sections.

The **B Section** contains data. The **B-bit** is zero.

The **BCH** is a cyclic error check algorithm, but can be conveniently calculated by XORing the values from the following table if the corresponding bit in the message is set:

Table 8.1: BCH Codes

Bit	Code	Bit	Code	Bit	Code	Bit	Code
A1	12	A8	0F	B1	13	B8	11
A2	09	A9	15	B2	1B	B9	1A
A3	16	A10	18	B3	1F	B10	0D
A4	0B	A11	0C	B4	1D	B11	14
A5	17	A12	06	B5	1C	B12	0A
A6	19			B6	0E		
A7	1E	A-bit	03	B7	07	B-bit	05

The **EOM** bit is 1 for the final Block in the message, or 0 otherwise.

8.2 Address Header

The address is always the first frame in a message. The format of the 12-bit address header is as follows:

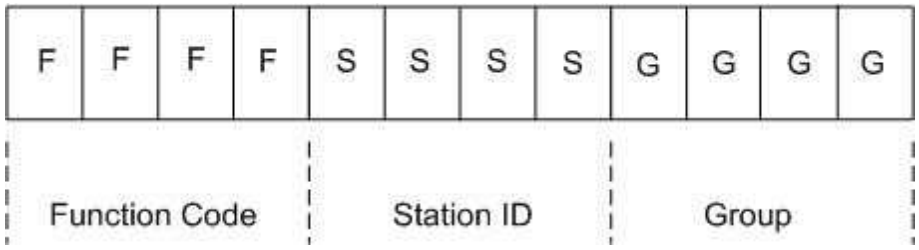

Figure 8.2: Conitel Address Header

The Function Codes are described below.

The Conitel protocol allows for 15 Station Addresses (1-15) with 0 reserved for a broadcast address. Each of these 15 individual station addresses can utilize 16 separate Groups. In theory, this means that the 240 unique 8-bit Station/Group numbers can be used for logical RTU's, or, conversely, a single RTU may be configured to respond to up to 240 combinations.